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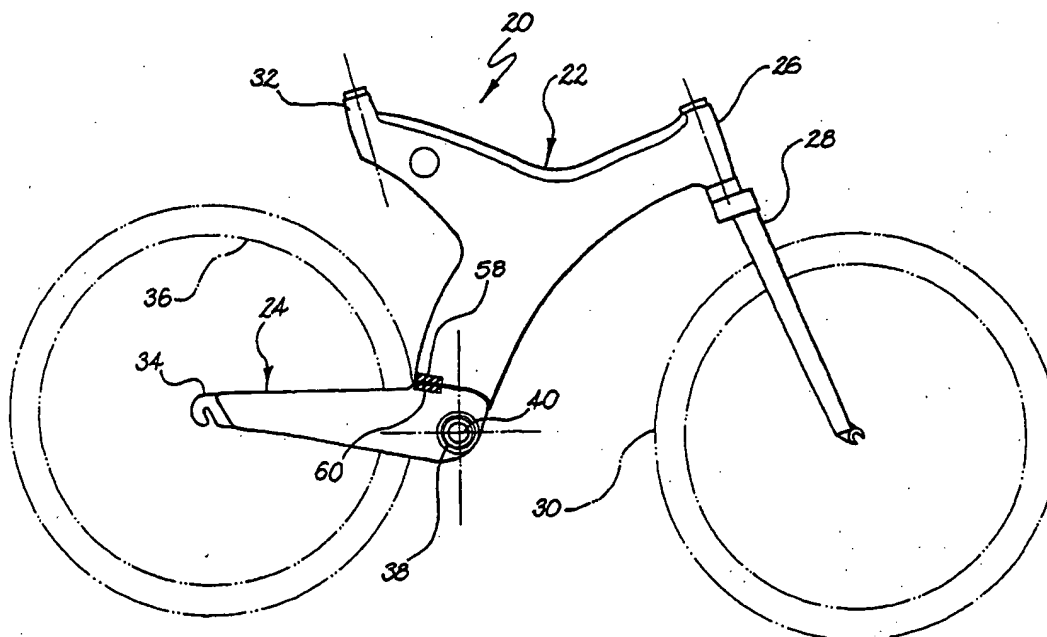
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(54) Title: A FOLDABLE BICYCLE FRAME



## (57) Abstract

A foldable bicycle frame (20) including a front sub-frame (22) adapted for mounting front forks (28) thereto, a rear sub-frame assembly (24) adapted for mounting a rear wheel (36) thereto, the rear sub-frame assembly (24) being pivotally mounted to the front sub-frame (22) for pivotal movement between an extended position locating the rear wheel (36) behind the front sub-frame (22) and a folded position locating the rear wheel (36) substantially adjacent the front forks (28) in a region vacated by removal of the front wheel (30).

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## A FOLDABLE BICYCLE FRAME

### FIELD OF THE INVENTION

The present invention relates to improvements in bicycle construction. The invention has been developed primarily for use as a multi-use recreational bicycle and will be described hereinafter with reference to this application. However, it will be appreciated that the invention is not limited to this particular field of use and is also applicable to road bicycles, track (velodrome) bicycles, mountain bicycles (mountain bikes) and BMX bicycles.

### BACKGROUND OF THE INVENTION

Bicycle riding is a popular sport and past time in many countries of the world. Bicycles are available in numerous configurations and levels of complexity.

### OBJECT OF THE INVENTION

It is an object of the present invention to provide improvements in bicycle construction.

### SUMMARY OF THE INVENTION

In a first aspect, the present invention discloses a bicycle frame including a front sub-frame adapted for mounting front forks thereto, and a rear sub-frame assembly adapted for mounting a rear wheel thereto, the rear sub-frame being pivotally mounted to the front sub-frame for pivotal movement between an extended position locating the rear wheel behind the front sub-frame and a folded position locating the rear wheel substantially adjacent the front forks in a region vacated by removal of the front wheel.

The rear sub-frame assembly preferably includes means to mount pedal crank arms and the rear sub-frame assembly pivots substantially about the axis of rotation of the pedal crank arms.

The frame preferably includes a releasable locking means for locking the rear sub-frame assembly in the extended position. In an embodiment, the releasable locking means is in the form of a "quick release" cammed skewer having a threaded shaft which passes through a hole in the rear sub-frame assembly to threadably engage a nut mounted to the front sub-frame. The nut is desirably pivotally mounted behind a metal yoke attached to the front sub-frame.

The frame preferably also includes one or more elastomers between adjacent surfaces of the front sub-frame and rear sub-frame assembly. In an embodiment, hollow cylindrical elastomers are disposed on the skewer shaft between the skewer head

and the underside of the rear sub-frame assembly and between the top of the rear sub-frame assembly and the underside of the metal yoke.

The front sub-frame preferably has a hollow boss mounted thereto and the rear sub-frame assembly is pivotally mounted to the boss. The bearing cartridge of the pedal crank arms is also preferably mounted to the boss.

In a second aspect, the present invention discloses a pair of rear drop outs for a bicycle frame, the drop outs being releasably fastenable to the bicycle frame and including means to mount ancillary components thereto.

Preferably, on the non driven side of the cycle, the drop outs are adapted for mounting of a hub brake arm or a disc brake calliper. On the drive side of the cycle frame, the drop outs are preferably adapted for mounting a tensioning idler for a belt or chain drive or a chain dérailleur.

In a third aspect, the present invention discloses a rear sub-frame assembly of a bicycle frame, the rear sub-frame assembly adapted for mounting a rear wheel of the bicycle thereto and including a forward portion and rear drop outs, the rear drop outs being releasably fastenable to the forward portion, wherein one or both of the forward portion or the rear drop outs include means to vary the fastening point between the front portion and the rear drop outs and thus vary the overall length of the rear sub-frame assembly.

In a preferred form, the drop outs include a series of holes or slots through which pass threaded fasteners adapted to engage nuts captive in the forward portion.

In a fourth aspect, the present invention discloses a bicycle frame according to the first aspect utilising the rear sub-frame assembly according to the third aspect.

In a fifth aspect, the present invention provides a cover for an upper and/or lower surface of a frame member of a bicycle frame, the cover including a substantially convex outer surface having two end portions each forming a smooth prolongation with adjacent side surfaces of the frame member.

In one form, the cover is soft or resilient and is desirably produced from an elastomer.

In another form, the cover is rigid and includes an internal channel adapted to cover adjacent external flanges of the frame member.

The cover preferably also includes recesses remote the outer surface which define hollows between the cover and the frame upper and/or lower surfaces for the concealed passage of brake and/or transmission cables or the like. The cover is preferably affixable to the frame member by gluing, clamping or the like.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a side view of a first embodiment of a bicycle frame in the extended position;

Fig. 2 is a side view of the bicycle frame shown in Fig. 1 in the folded position;

Fig. 3 is an enlarged partial cross-sectional side view of the bicycle frame shown in Fig. 1;

5 Fig. 4 is a side view similar to Fig. 3 showing different elastomers;

Fig. 5 is a side view of a first embodiment of a rear sub-frame assembly;

Fig. 6 is a side view of a second embodiment of a rear sub-frame assembly;

Fig. 7 is a side view of a third embodiment of a rear sub-frame assembly;

Fig. 8 is a side view of a fourth embodiment of a rear sub-frame assembly;

10 Fig. 9 is a side view of a fifth embodiment of a rear sub-frame assembly;

Fig. 10 is a partial underside view of the embodiment shown in Fig. 9;

Fig. 11 is a side view of a second embodiment of a bicycle frame;

Fig. 12 is a side view of a third embodiment of a bicycle frame;

15 Fig. 13 is a cross-sectional end view of a first embodiment of a cover for a frame member of a bicycle frame;

Fig. 14 is a perspective view of a bicycle incorporating the cover shown in Fig. 13; and

Fig. 15 is a side view of a fourth embodiment of a bicycle frame.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

20 Referring firstly to Figs. 1 and 2, there is shown a first embodiment of a bicycle frame 20. The frame 20 is basically comprised of a front sub-frame 22 and a rear sub-frame assembly 24 which are both preferably manufactured from carbon fibre layered over a foam core. The front sub-frame 22 includes a stem 26 for mounting front forks 28 which locate a front wheel in the general position indicated by phantom lines 30. The front sub-frame 22 also includes a rear stem 32 for mounting a seat, seat post and locating clamp (all not shown).

30 The rear sub-frame assembly 24 includes drop outs 34 for mounting a rear wheel indicated by phantom lines 36. The rear sub-frame assembly 24 is mounted to the front sub-frame 22 at boss 38 for pivotal movement about axis 40 between an extended position (as shown in Fig. 1) in which the rear wheel 36 is located behind the front sub-frame 22 and a folded position (as shown in Fig. 2) in which the rear wheel 36 is located substantially adjacent the front forks 28 in a region vacated by removal of the front wheel 30. The front wheel 30 can be conveniently removed by loosening of a conventional "quick release" cammed skewer between the wheel nuts, as is well known  
35 in the art.

In this embodiment, the bearing cartridge of the pedal crank set (not shown) is also mounted to the boss 38 such that the axis of rotation of the pedal crank set is coincident with the axis of rotation 40 of the rear sub-frame assembly 24. The

coincident rotational axes provide the advantage that tension in a chain or belt drive between the pedal crank set and a rear sprocket are not affected during folding of the frame 20 into the position shown in Fig. 2.

The primary advantage of the frame 20 shown in Figs. 1 and 2 is that the rear sub-frame assembly 24 can be pivoted in the direction indicated by arrow 41 into a folded configuration for transport and storage purposes and in which the length of the bicycle is substantially reduced. Further, the folding can be achieved without necessitating removal of the rear wheel and thereby avoiding contact with potentially messy rear drive components such as sprockets, dérailleur, chain and the like.

As best seen in Fig. 3, the rear sub-frame 24 can be locked in the extended position shown in Fig. 1 by a conventional "quick release" cammed skewer 42. Cyclists are generally conveniently familiar with such skewer as they are also used for locating front and rear wheels and seat posts.

The shaft 44 of the skewer engages a nut 46 restrained adjacent the front sub-frame 22 by a metal yoke 48 attached the rear sub-frame 22. The shaft 44 passes through a hole 50 provided in a boss 52 located between the two forks or legs of the rear sub-frame 24. An upper cylindrical elastomer 54 is disposed on the shaft 44 between the metal yoke 48 and the top of the rear sub-frame assembly boss 50. A lower elastomer 56 is disposed on the shaft 44 between the underside of the boss 50 and the head 55 of the skewer 42.

The upper elastomer 54 provides a degree of shock absorbence and suspension travel to the rear wheel of the bicycle when encountering bumps or rough surfaces. The suspension travel indicated by arrows 57 increases rider comfort and minimises loss of contact between the rear wheel and the ground. The lower elastomer 56 provides a controlled rate of return to the "stable" position shown in Fig. 3 after such a disturbance.

The nut 46 is able to pivot about an axis substantially parallel to the rotational axis 40 of the rear sub-frame 24 to allow for angular movement of the skewer shaft 44 during such disturbances and accommodate various elastomer sizes.

Referring to Fig. 4, the relative sizes of the upper and lower elastomers 54 and 56 respectively can be altered, as shown, to adjust the stable position of the rear sub-frame assembly 24 relative to the front sub-frame 22. The stable position of the sub-frame assembly 24 when using the elastomers 54 and 56 shown in Fig. 3 is shown in phantom in Fig. 4. By altering the stable position of the rear sub-frame assembly 24 by changing the elastomers 54 and 56, the height, ground clearance, centre of gravity and wheel base of the frame 20 can be easily and quickly altered.

If a rigid frame is desired the elastomers 54 and 56 can be removed or replaced with like rigid components.

Further, if desired, relatively soft elastomers 54 and 56 can be provided on the shaft 44 of the skewer 42 and other relatively hard elastomers can be provided (such as those indicated by reference numerals 58 and 60 in Fig. 1) between other adjacent surfaces of the front sub-frame 22 and rear sub-frame assembly 24 to act as final bump stops in the event the softer elastomers 54 and 56 are fully compressed.

Figs. 5 to 8 shows various embodiments of the rear sub-frame assembly 24. In these embodiments, the rear sub-frame assembly 24 is comprised of rear drop outs 70 which are releasably fastened to a forward portion 72. In these drawings, the rear drop outs 70 include means to allow ancillary bicycle components to be mounted to the rear drop outs 70. In the prior art, ancillary components are mounted to fittings welded or otherwise fixed to the frame itself, not the rear drop outs. By providing the means to mount components on the rear drop outs 70 a common forward portion 72 of the rear sub-frame assembly 24 can be produced for use with one of a selection of the drop outs 70 to produce many different rear sub-frame assemblies 24 whilst minimising inventory. For example, Fig. 5 shows a driven side of the rear sub-frame assembly 24 having a flange 74 suitable for mounting a tensioning idler for a chain or belt drive. Fig. 6 shows a rear extension 76 for mounting a d  railleur. Fig. 7 shows the non driven side of a bicycle frame in which the drop out 70 includes a lower flange 78 for mounting the stationary arm of a hub or back pedal brake. Fig. 8 shows a flange 79 with provision for mounting the calliper of a disc brake assembly.

A further embodiment of the rear sub-frame assembly 24 is shown in Figs. 9 and 10 in which the point of attachment between the forward portion 80 and drop out 82 can be varied and thus vary the overall length of the rear sub-frame assembly 24. In the embodiment shown, the forward portion 80 includes four captive nuts (not shown) and the rear drop outs 82 include four slots 86 through which pass the four bolts 88 and engage the nuts. This arrangement allows the length of the rear sub-frame assembly 24 to be adjusted for use with standard belt or chain sizes, different wheel sizes and different braking configurations. Further, as with the embodiments described with references to Figs. 5 to 8, this arrangement reduces component inventory and provides greater ease of modification or adaptation. For example, by adjusting the length of the rear sub-frame assembly 24 and selecting appropriate front forks, a single frame can be configured as a 24" or 26" (nominal wheel size) bicycle.

Fig. 11 shows another embodiment of a bicycle frame 20 in which the rear drop out 84 includes means for pivotally connecting one end of a first member 90. A second member 92 connects the other end of the first member 90 to the front sub-frame 22. The first member 90, the second member 92, the front sub-frame 22 and the rear sub-frame assembly 24 thus form a truss having pivotable joints whose movement is controlled by shock absorber 94 to provide further suspension travel to the rear sub-frame assembly 24.

A similar version of this rear suspension arrangement is shown in Fig. 12 and like reference numerals are used to denote like components. However, in the embodiment shown in Fig. 12, the first member 90 is pivotally connected to forward portion 96 of the rear sub-frame assembly 24.

5 In both of the embodiments shown in Fig. 11 and Fig. 12, one end of the first member 90 can include a releasable connection to enable the rear sub-frame assembly 24 to be disconnected from the other truss components for folding of the frame in a similar manner to that shown in Fig. 2.

Fig. 13 is a sectional end view of a frame member 100 of the bicycle frame 20. The frame member 100 is preferably formed from a substantially foam core 102 over which is bonded carbon fibre layers 104 which join and terminate along protruding flanges 106. Covers 108 are provided on the upper 110 and lower 112 surfaces of the frame member 100. The covers 108 includes a convex outer surface 114 having two end portions 116 which form a smooth prolongation with adjacent sides surfaces 117 of the frame member 100. This provides a smooth, rounded and distinctive appearance to the bicycle frame.

In the embodiment shown the covers 108 also includes recesses 118 either side of an internal central rib 120. The central rib 120 includes a channel 121 adapted to cover the flanges 106. The recesses 118 define a hollow between the cover and the frame upper and lower surfaces 110 and 112 for the concealed passage of brake and/or transmission cables 122 and the like.

Fig. 14 shows a rear brake cable 124 being concealed by a cover 108 attached to the lower surface of the front sub-frame 22.

The covers 108 can be produced from a soft or resilient elastomeric material to minimise any injuries that could be caused by a rider impact.

Alternatively, the covers 108 can be produced from a rigid material, such as carbon fibre. In this form, the channel 121 prevents separation of the flanges 106 when the frame member 100 is under high load.

A cover 108 on the upper surface of the front sub-frame 22 is also shown in the embodiment of the bicycle shown in Fig. 12.

Fig. 15 shows another embodiment of a bicycle frame 20 with a shock absorber 130 mounted between the front sub-frame 22 and the rear sub-frame assembly 24. As with the embodiments of Fig. 11 and Fig. 12, one end of the shock absorber 130 can include a releasable connection to allow folding of the frame 20.

35 Although the invention has been described with reference to specific examples, it will be appreciated by those skilled in the art that the invention may be embodied in many other forms.



## CLAIMS:

1. A bicycle frame including a front sub-frame adapted for mounting front forks thereto, and a rear sub-frame assembly adapted for mounting a rear wheel thereto, the rear sub-frame being pivotally mounted to the front sub-frame for pivotal movement between an extended position locating the rear wheel behind the front sub-frame and a folded position locating the rear wheel substantially adjacent the front forks in a region vacated by removal of the front wheel.
2. The frame as claimed in claim 1, wherein the rear sub-frame assembly includes means to mount pedal crank arms and the rear sub-frame assembly pivots substantially about the axis of rotation of the pedal crank arms.
3. The frame as claimed in claim 2, wherein the front sub-frame has a hollow boss mounted thereto and the rear sub-frame assembly is pivotally mounted to the boss.
4. The frame as claimed in claim 3, wherein the bearing cartridge of the pedal crank arms is also mounted to the boss.
5. The frame as claimed in claim 1, wherein the frame includes one or more elastomers between adjacent surfaces of the front sub-frame and rear sub-frame assembly.
6. The frame as claimed in claim 1, wherein the frame includes a releasable locking means for locking the rear sub-frame assembly in the extended position.
7. The frame as claimed in claim 6, wherein the releasable locking means is a "quick release" cammed skewer having a threaded shaft which passes through a hole in the rear sub-frame assembly to threadably engage a nut mounted to the front sub-frame.
8. The frame as claimed in claim 7, wherein the nut is pivotally mounted behind a metal yoke attached to the front sub-frame.
9. The frame as claimed in claim 6, wherein hollow cylindrical elastomers are disposed on the skewer shaft between a skewer head and the underside of the rear sub-frame assembly and between the top of the rear sub-frame assembly and the underside of the metal yoke.
10. A pair of rear drop outs for a bicycle frame, the drop outs being releasably fastenable to the bicycle frame and including means to mount ancillary components thereto.
11. The rear drop outs as claimed in claim 10, wherein the drop outs are adapted for mounting of a hub brake arm or a disc brake calliper.
12. The rear drop outs as claimed in claim 10, wherein the drop outs are adapted for mounting a tensioning idler for a belt or chain drive or a chain dérailleur.

13. The rear drop outs as claimed in claim 10, wherein the drop outs are adapted for mounting an end of a shock absorber or other suspension component.

14. A rear sub-frame assembly of a bicycle frame, the rear sub-frame assembly adapted for mounting a rear wheel of the bicycle thereto and including a forward portion and rear drop outs, the rear drop outs being releasably fastenable to the forward portion, wherein one or both of the forward portion or the rear drop outs include means to vary the fastening point between the front portion and the rear drop outs and thus vary the overall length of the rear sub-frame assembly.

15. The rear sub-frame assembly as claimed in claim 14, wherein the drop outs include a series of holes or slots through which pass threaded fasteners adapted to engage nuts captive in the forward portion.

16. A bicycle frame according to that claimed in claim 1 utilising the rear sub-frame assembly according to that claimed in claim 14.

17. A cover for an upper and/or lower surface of a frame member of a bicycle frame, the cover including a convex outer surface having two end portions each forming a smooth prolongation with adjacent side surfaces of the frame member.

18. The cover as claimed in claim 17, wherein the cover is soft or resilient.

19. The cover as claimed in claim 17, wherein the cover is produced from an elastomer.

20. The cover as claimed in claim 17, wherein the cover is rigid and includes an internal channel adapted to cover adjacent external flanges of the frame member.

21. The cover as claimed in claim 17, wherein the cover includes at least one recess remote the outer surface which defines at least one hollow between the cover and the frame upper and/or lower surfaces for the concealed passage of brake and/or transmission cables or the like.

22. The cover as claimed in claim 21, wherein the cover is affixable to the frame member by gluing, clamping or the like.

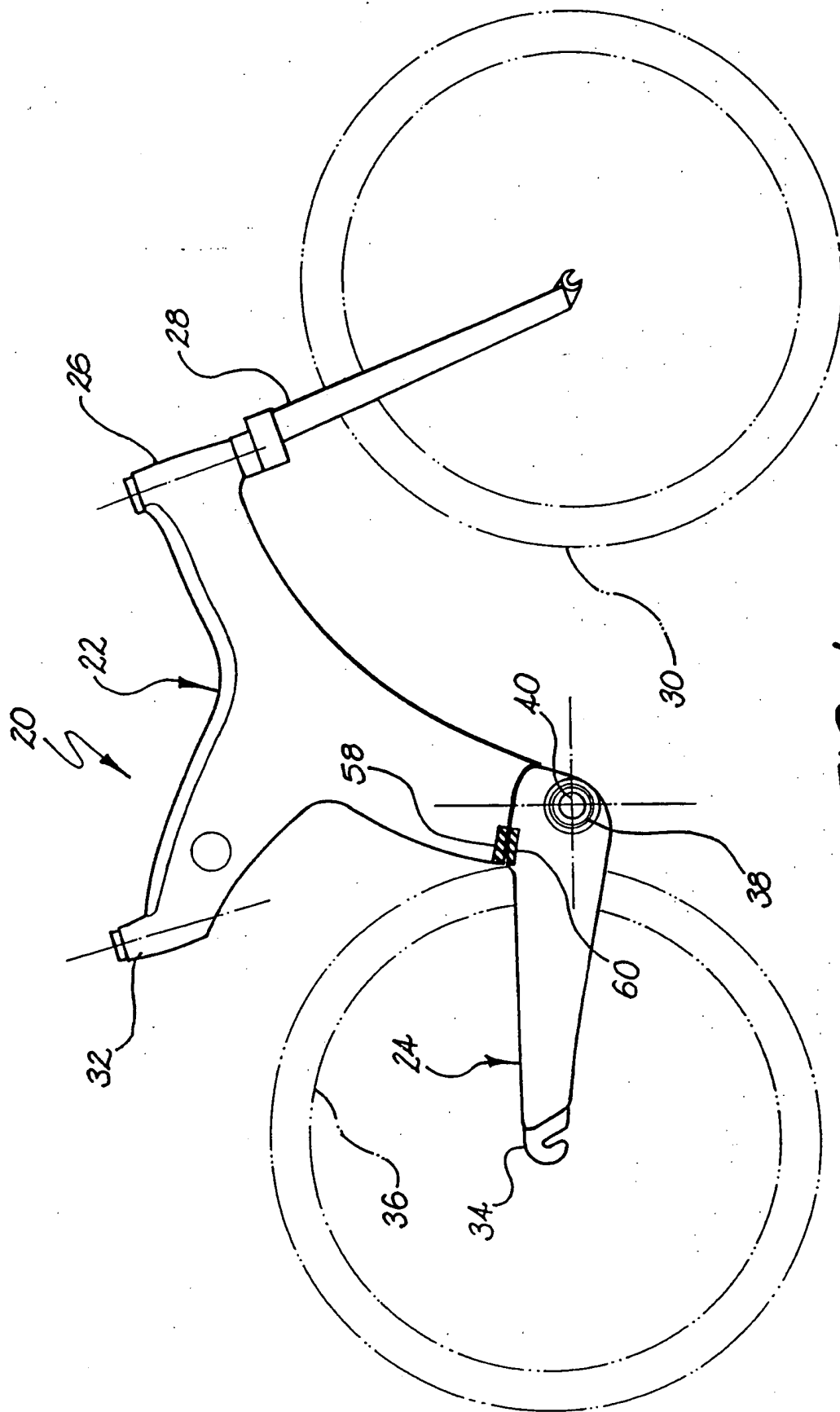
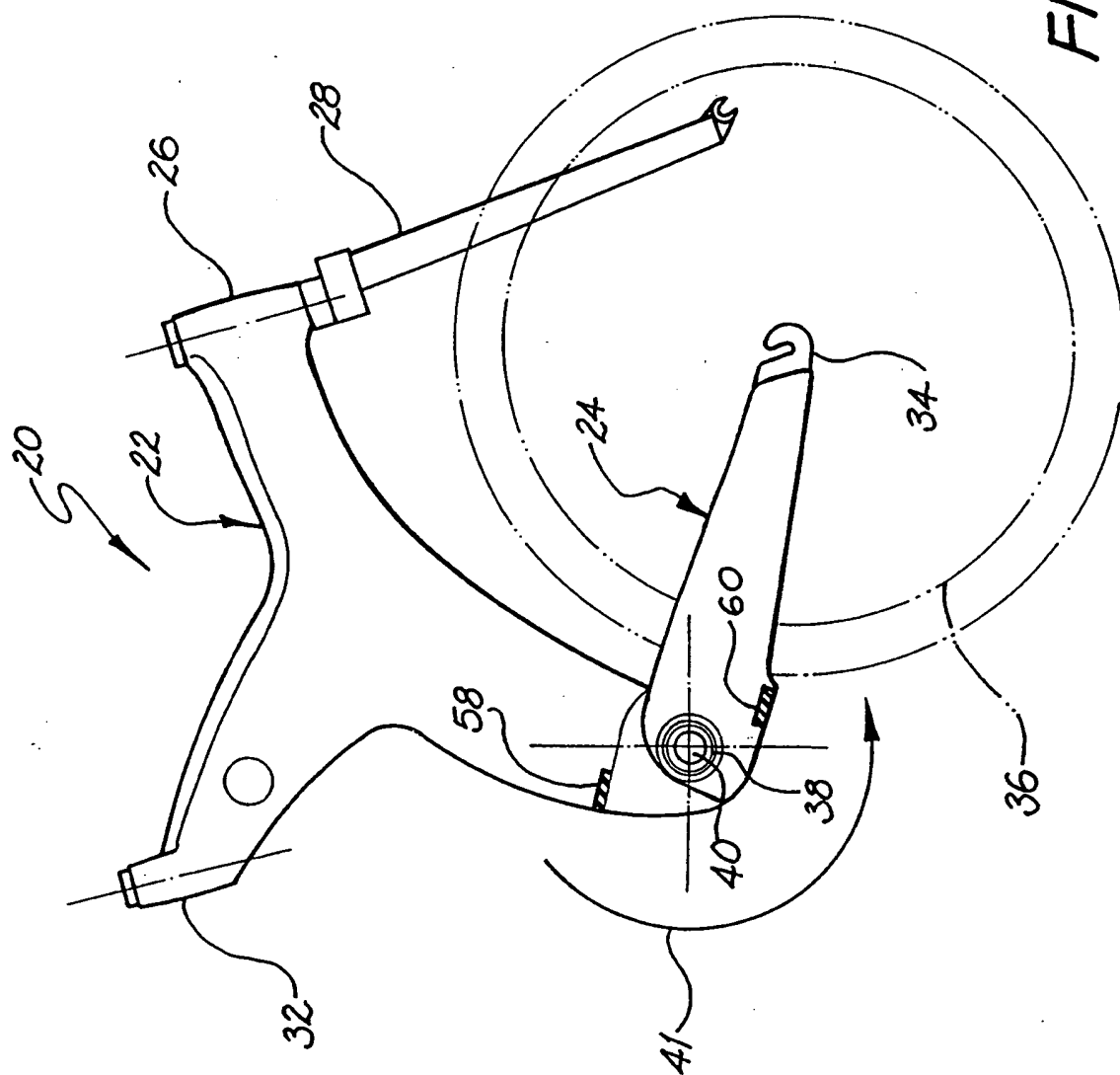
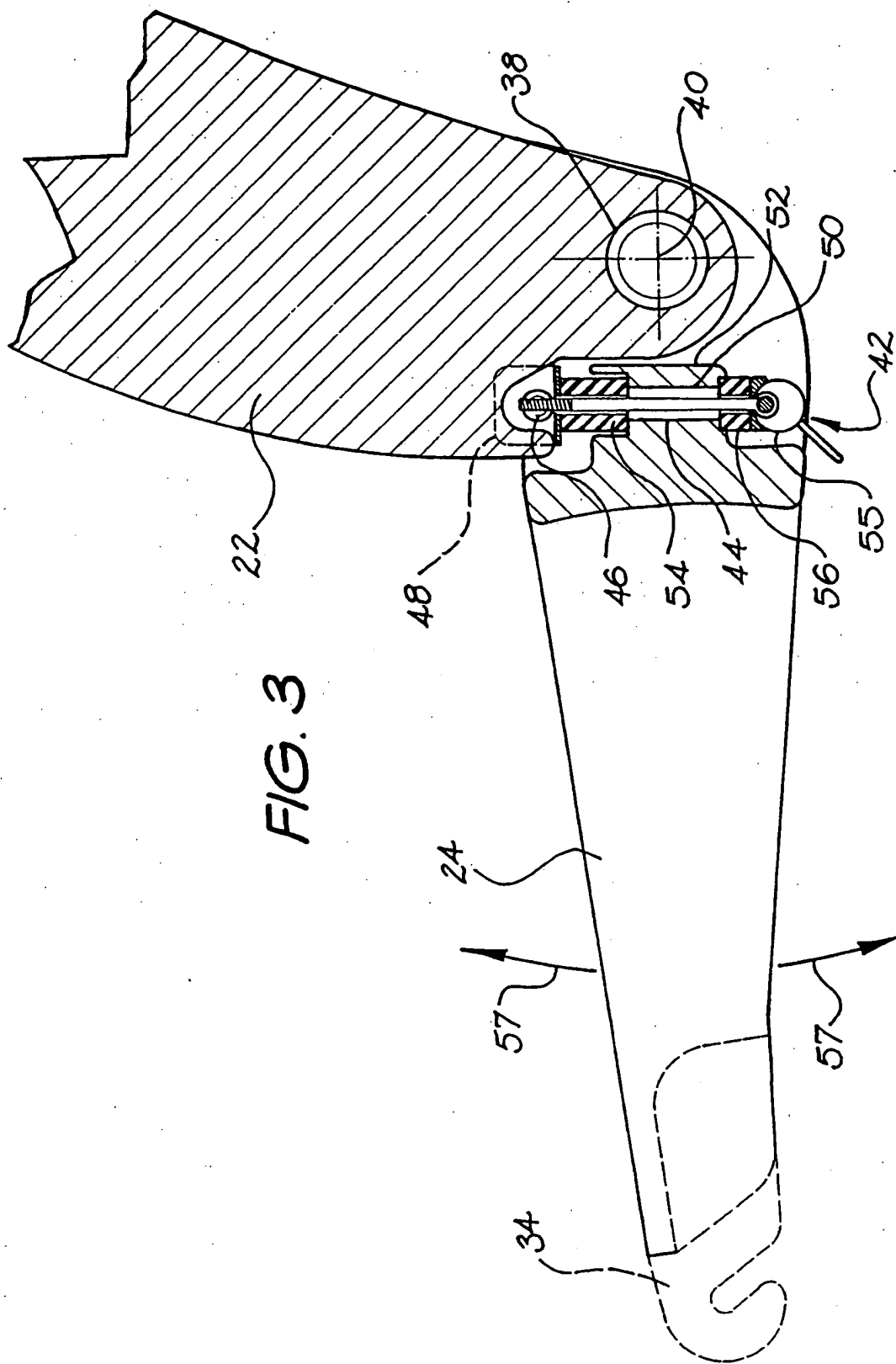
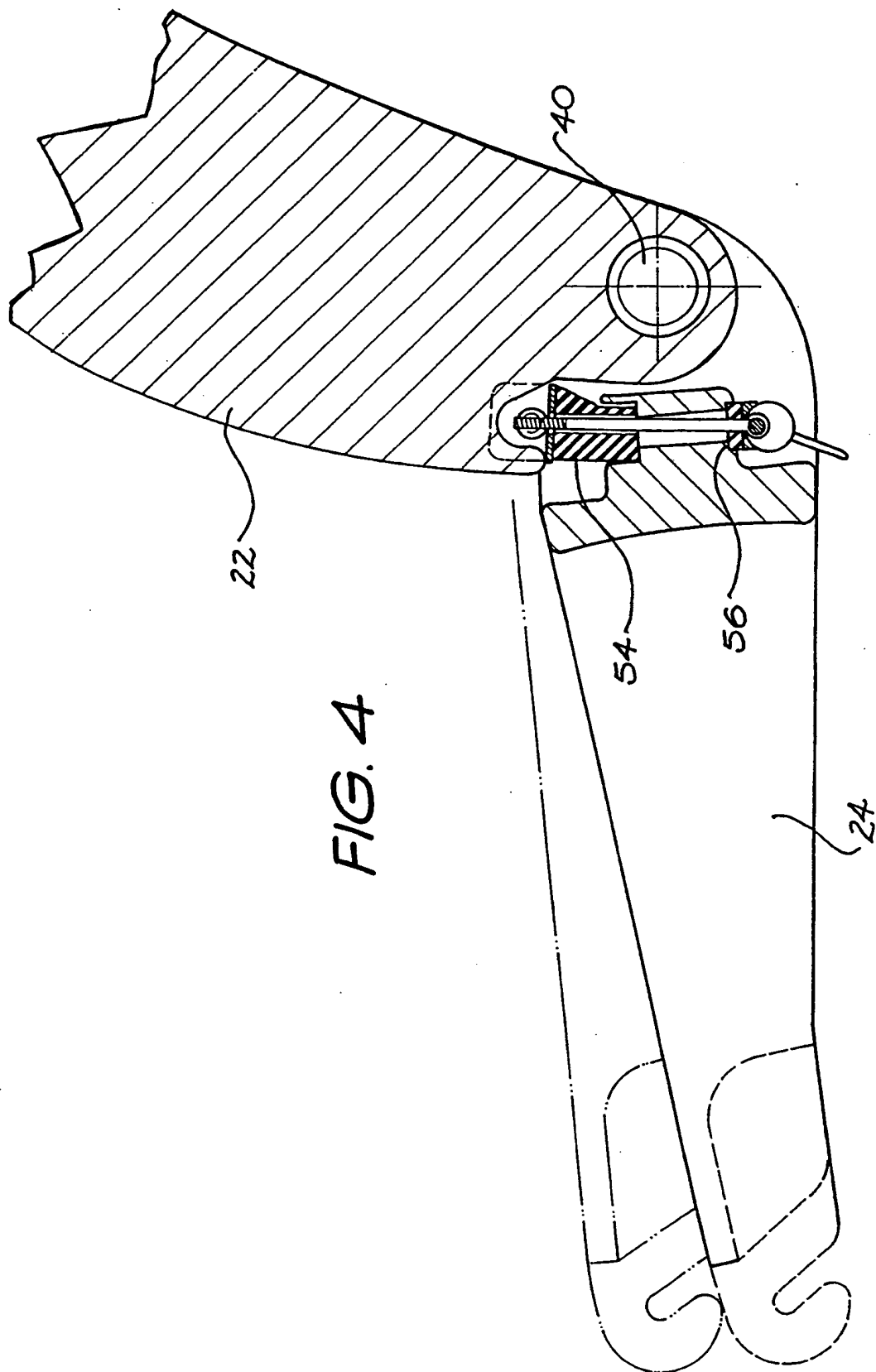
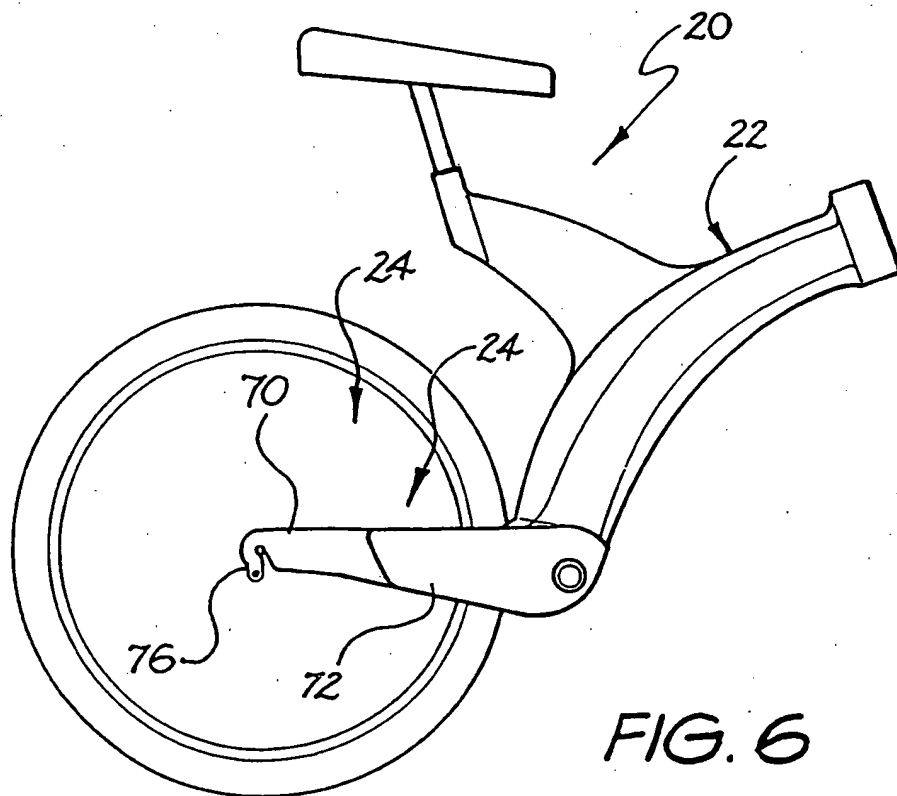
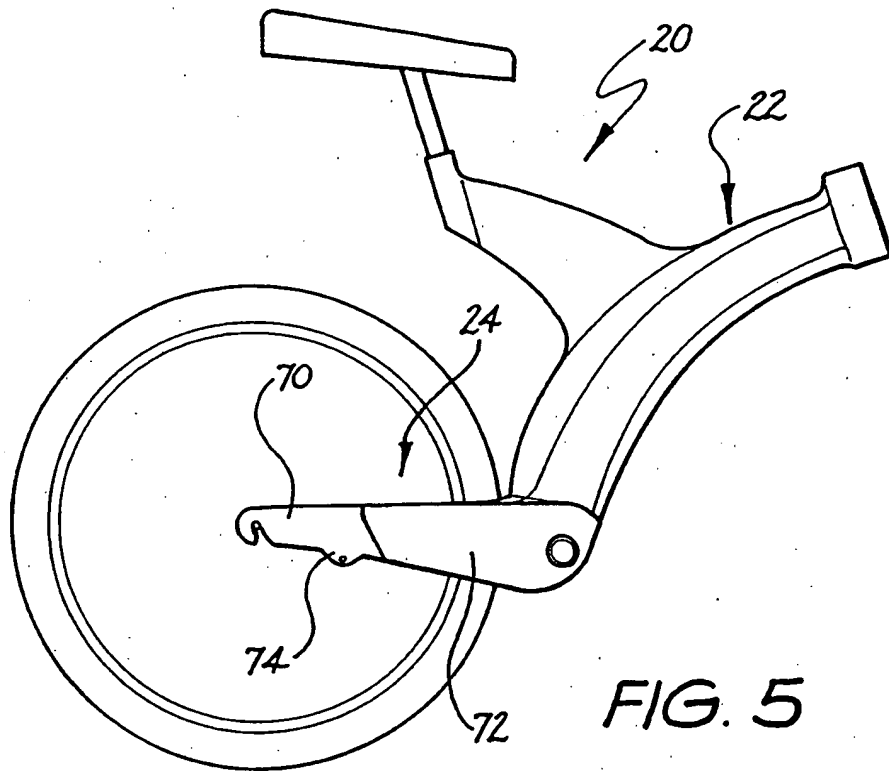


FIG. 1









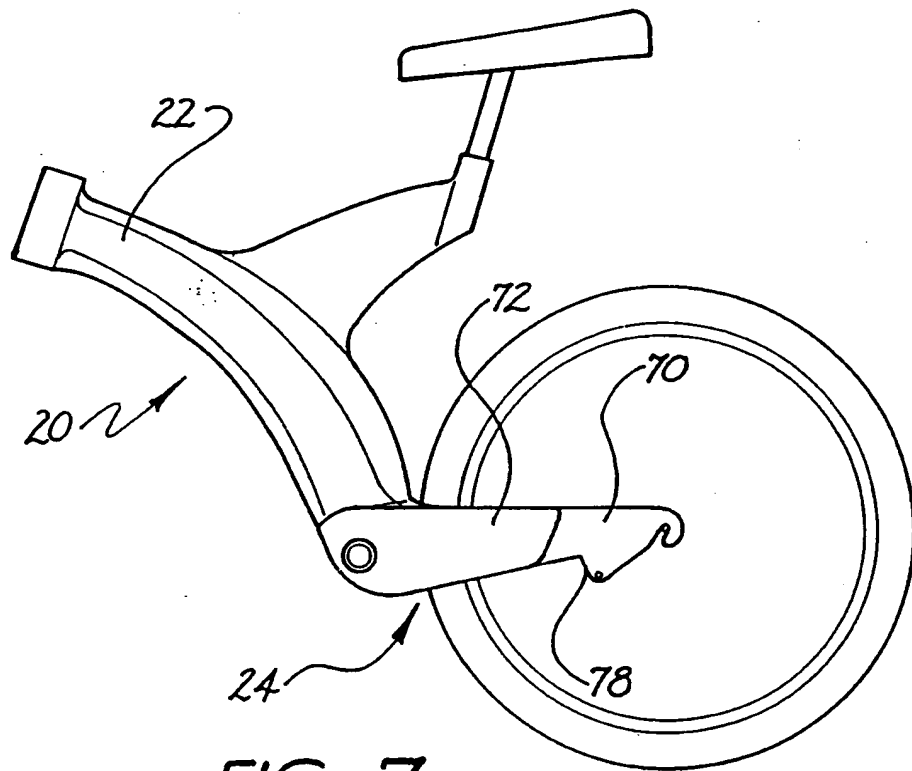


FIG. 7

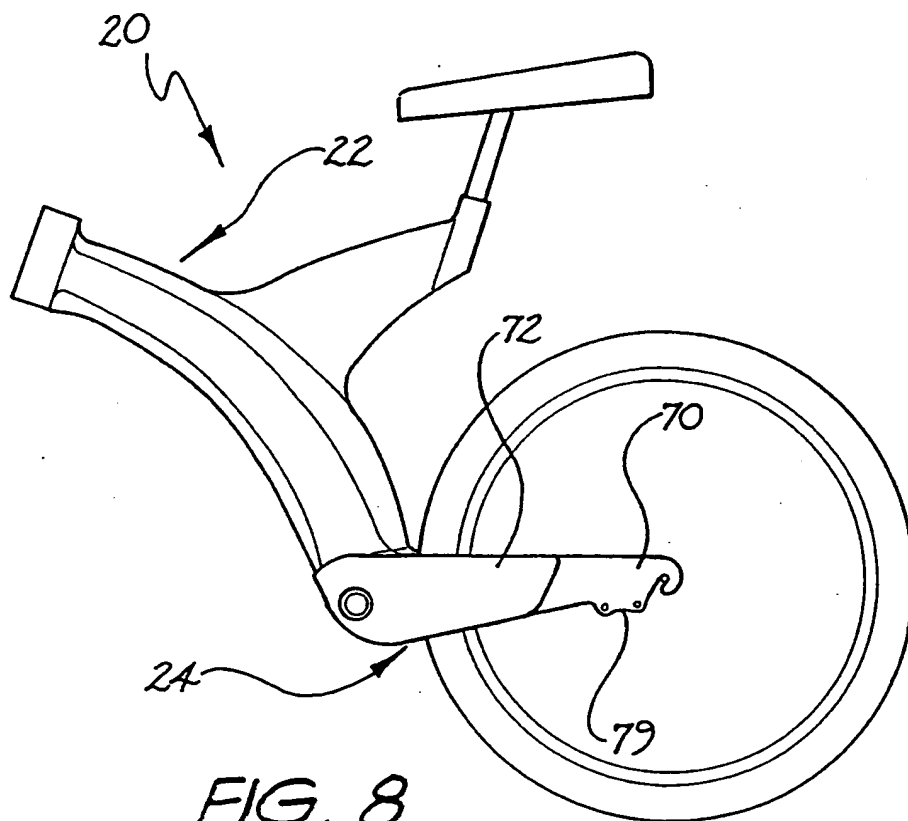
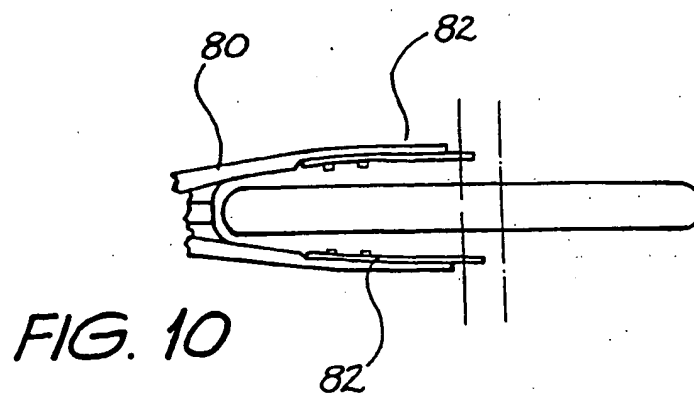
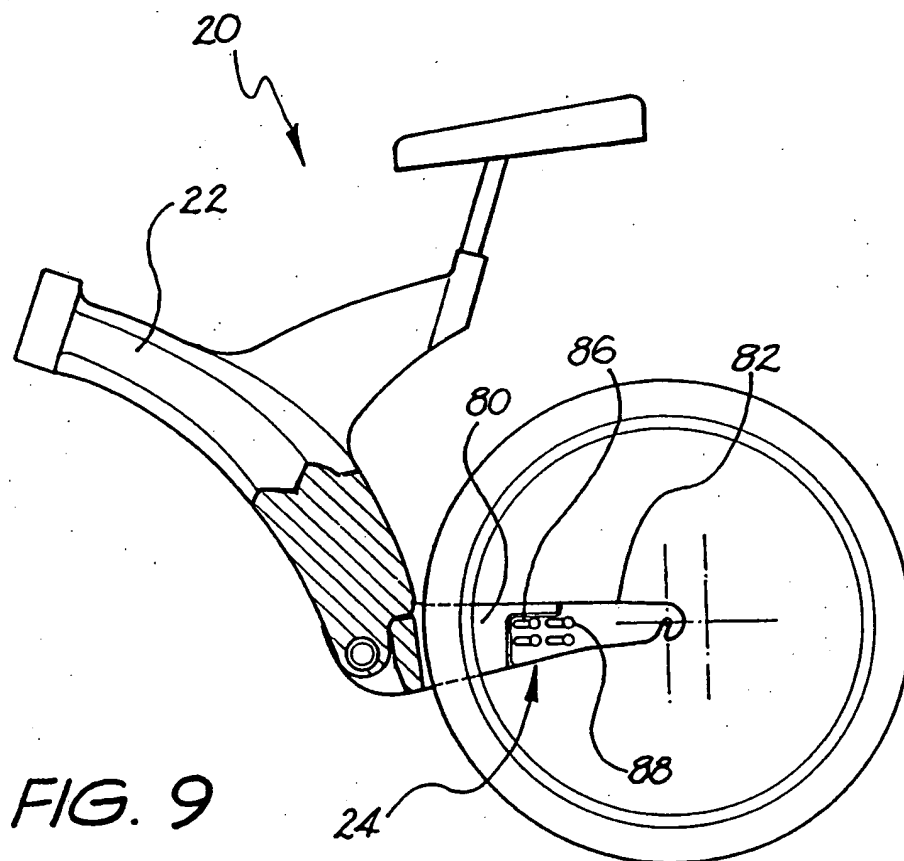
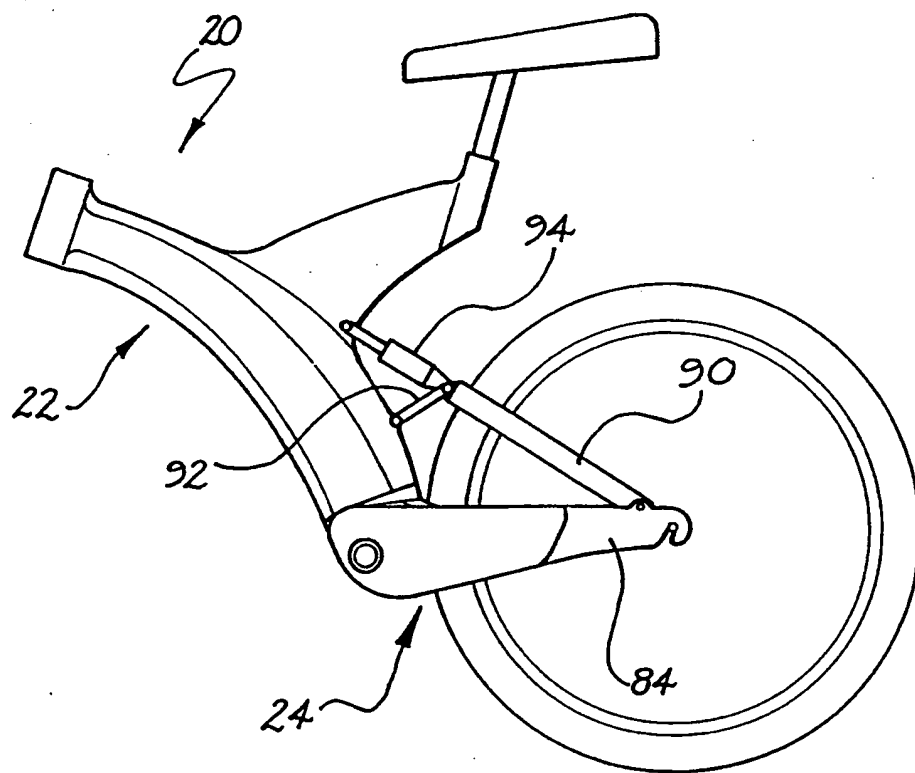


FIG. 8



7/12



*FIG. 11*

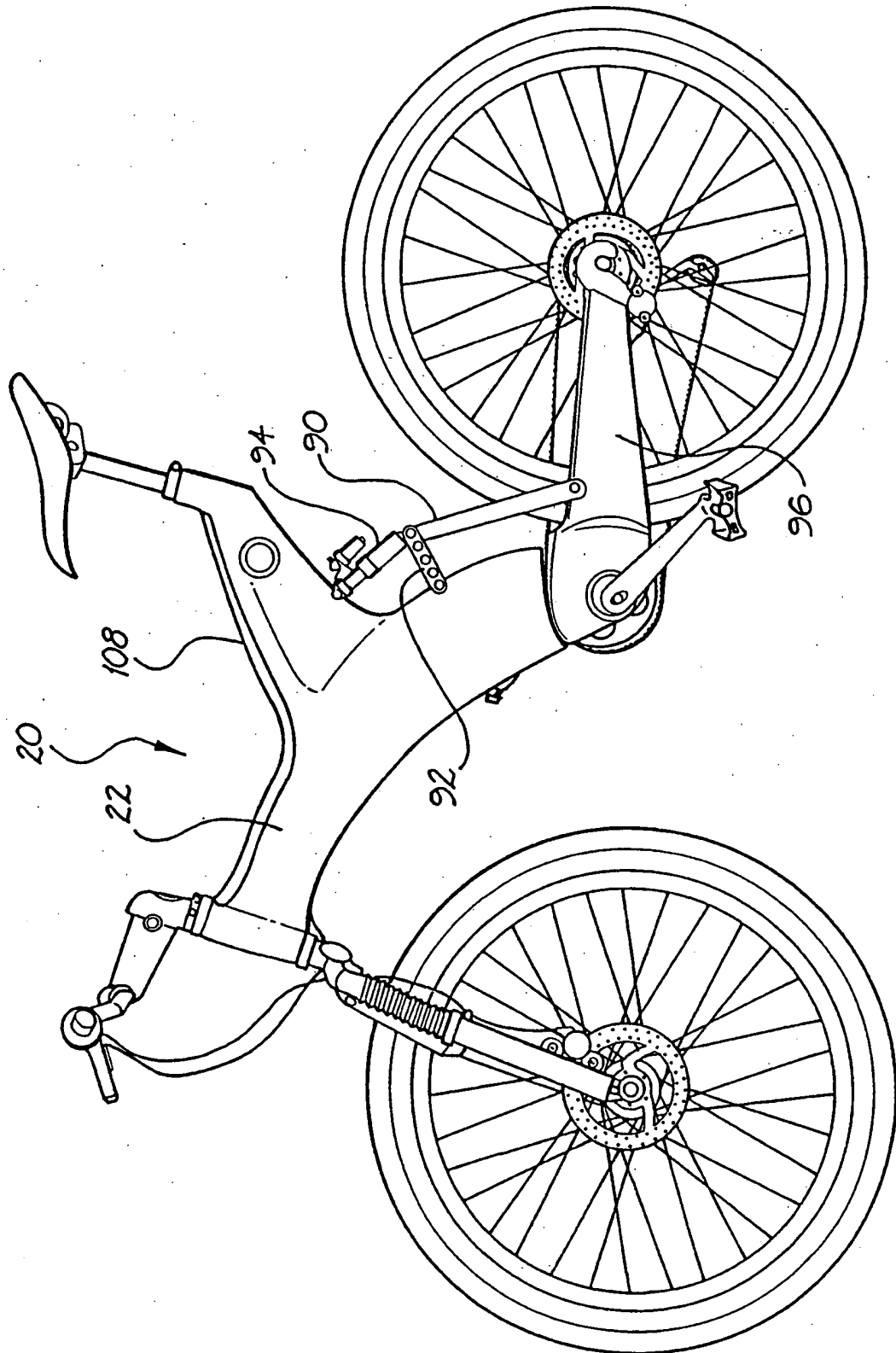


FIG. 12

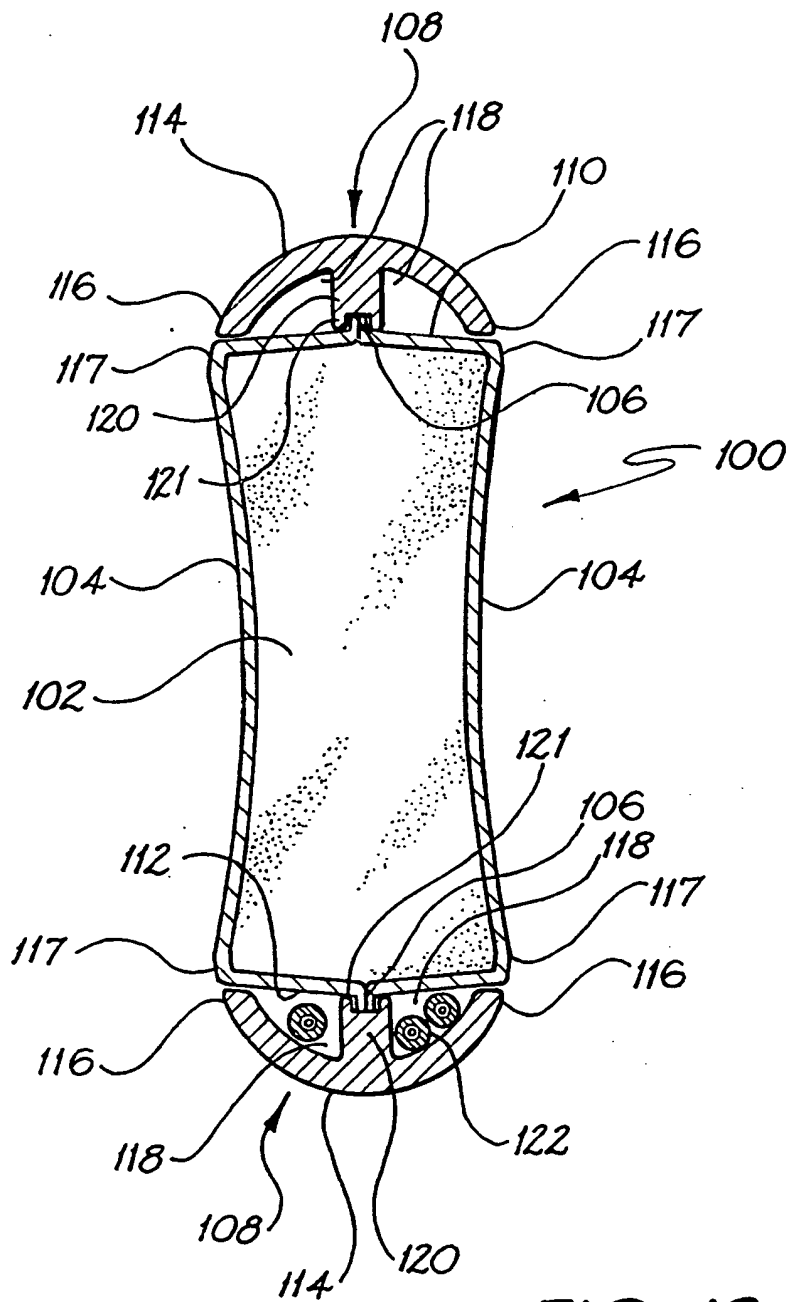


FIG. 13

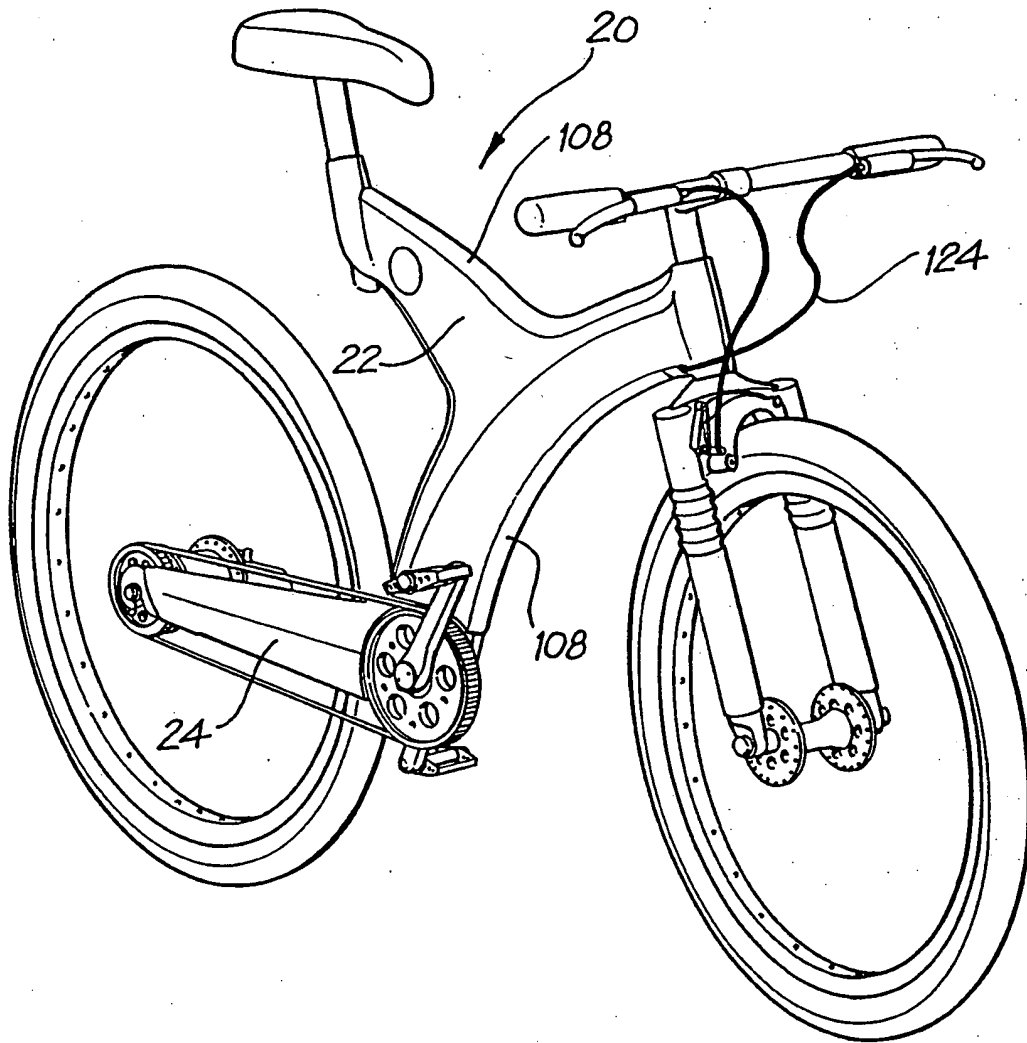
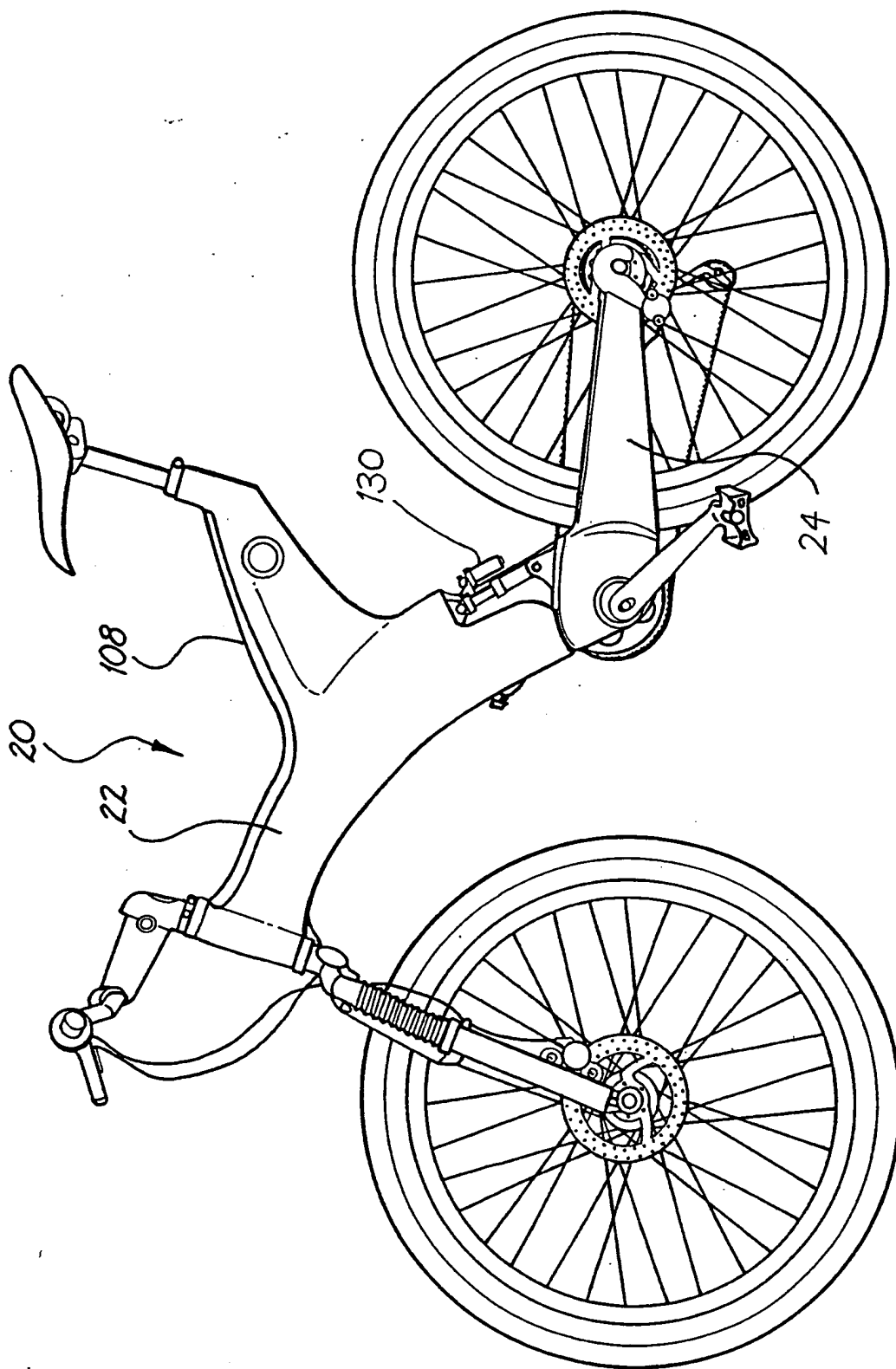


FIG. 14



# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/AU 99/00582

## A. CLASSIFICATION OF SUBJECT MATTER

Int Cl<sup>6</sup>: B62K 15/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
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## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 97/10141 A (HACKERT), 20 March 1997 Whole document	1-8
X	EP 565760 A1 (TS'AO), 20 October 1993 Whole document	1-8
X	DE 3111358 A1 (SCHUBERTH), 7 October 1982 Whole document	1,5-8

☒ Further documents are listed in the continuation of Box C

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International application No.  
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 129164 A2 (BRIDGESTONE CYCLE CO, LTD), 27 December 1984 Whole document	1,5-8
X	DE 3931798 A1 (STROZYK), 5 April 1990 Whole document	1,5-8



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International Application No.

PCT/AU 99/00582

## Box I Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

## Box II Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See attachment Box II supplement.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims: it is covered by claims Nos.: 1-9

### Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU 99/00582

## Box II Supplement

The international application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept. In coming to this conclusion the International Searching Authority has found that there are four inventions:

- 1 Claims 1-9 directed to a bicycle frame including a front sub-frame with front forks, a rear sub-frame assembly, the rear sub-frame assembly being pivotally mounted to the front sub-frame for pivotal movement between an extended position locating a rear wheel behind the front sub-frame and a folded position locating the rear wheel substantially adjacent the front forks in a region vacated by removal of the front wheel. It is considered that the pivotal movement between an extended position locating the rear wheel behind the front sub-frame and a folded position locating the rear wheel substantially adjacent the front forks in a region vacated by removal of the front wheel comprises a first "special technical feature".
- 2 Claims 10-13 directed to a pair of rear drop outs for a bicycle frame, the drop outs being releasably fastenable to the bicycle frame and including means to mount ancillary components thereto. It is considered that the drop outs being releasable fastenable to the bicycle frame and including means to mount ancillary components thereto comprises a second "special technical feature".
- 3 Claims 14-16 directed to a rear sub-frame assembly of a bicycle frame, the assembly including a forward portion and rear drop outs, the rear drop outs being releasably fastenable to the forward portion, wherein one or both of the forward portion or the rear drop outs include means to vary the fastening point between the front portion and the rear drop outs and thus vary the overall length of the rear sub-frame assembly. It is considered that one or both of the forward portion or the rear drop outs include means to vary the fastening point between the front portion and the rear drop outs and thus vary the overall length of the rear sub-frame assembly comprises a third "special technical feature".
- 4 Claims 17-22 directed to a cover for an upper and/or lower surface of a frame member of a bicycle frame, the cover including a convex outer surface having two end portions each forming a smooth prolongation with adjacent side surfaces of the frame member. It is considered that the cover including a convex outer surface having two end portions each forming a smooth prolongation with adjacent side surfaces of the frame member comprises a fourth "special technical feature".

Since the above mentioned groups of claims do not share any of the technical features identified, a "technical relationship" between the inventions, as defined in PCT rule 13.2 does not exist. Accordingly, the international application does not relate to one invention or to a single inventive concept.

### Information on patent family members

International application No.  
PCT/AU 99/00582

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report				Patent Family Member			
WO	97/10141	AU	76184/96	CA	2231866	EP	851825
		DE	19636900				
EP	565760	US	5312125				
DE	3111358	NONE					
EP	129164	JP	59230878	US	4579360		
DE	3931798	CN	1050521	AU	43279/89	CA	1313383
		EP	442895	GB	2248591	US	5193834

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